Magnetic resonance imaging in pseudotumor cerebri

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Aims and objectives

There have been many attempts in the past to define objective structural signs on cross-sectional imaging that would actually identify idiopathic intracranial hypertension patients; most reports regarding the subject conclude that in the appropriate clinical setting, there are several neuroimaging signs that, although not specific, can assist in establishing the diagnosis of idiopathic intracranial hypertension.

The cross-sectional imaging signs previously reported to be of value in idiopathic intracranial hypertension include: empty sella turcica, slit-like ventricles, tight subarachnoid spaces, flattening of the posterior sclera, protrusion of the optic nerve (reversal of the optic nerve), enhancement of the optic nerve head, distention of the optic nerve sheath and vertical tortuosity of the optic nerve.

The aim of this study was to evaluate the accuracy of these previously reported structural cross-sectional signs in the diagnosis of idiopathic intracranial hypertension and to determine whether magnetic resonance (MR) imaging can be used to predict the presence of elevated intracranial pressure.
Methods and materials

Retrospective case series of 16 patients with pseudo tumor cerebri and 16 control subjects. Patients were identified using our clinical database of patients with idiopathic intracranial hypertension (IIH).

Patients were included if they had an MRI study of the brain performed at our institution from January 2007 through November 2014 and had visual field and lumbar puncture data available for review.

All of the 16 control subjects were originally recruited from population of cancer patients of our institution who underwent screening for brain metastasis. Control subjects had no overt signs or symptoms of neurologic disease and had normal enhanced brain MRI.

All patients had brain MRI and MR venous angiography. MRI was performed at 1.5 T (GE Healthcare) using a standard head coil. All patients underwent a standardized brain MRI protocol including unenhanced axial diffusion weighted imaging, T1-weighted, T2*-weighted, and T2-weighted sequences, sagittal T1-weighted sequences and thin (3mm slice thickness) fat suppressed T2 axial, coronal and sagittal oblique weighted sequences for orbits.

All patients except four (10/16) received IV gadolinium contrast material at a standard dose (0.1 mmol/ kg). All patients also underwent MRV concurrent with the MRI evaluation: 10 patients underwent contrast-enhanced MRV and 6 patients, unenhanced MRV.

The presence or absence of the following seven neuroimaging signs was measured: (1) flattening of the posterior sclera; (2) enhancement of the prelaminar optic nerve; (3) distension of the perioptic subarachnoid space; (4) intraocular protrusion of the prelaminar optic nerve; (5) vertical tortuosity of the orbital optic nerve; transverse sinus stenosis (6) and (7) empty sella.

Fisher’s exact test was used to assess the quality of prevalence of the sign in control and disease subjects. The sensitivity, specificity, likelihood ratio positive (LR+) and likelihood ratio negative (LR-) were also calculated to measure the diagnostic strength of the sign.
Results

Images of 16 idiopathic intracranial hypertension patients and 16 control subjects were reviewed for this study. A patient group considered of 12 females and 4 males, ages 18-66 years (mean 37.2 years, median 35 years). The control group included 12 females and 4 males, ages 23-81 years (mean 59.6 years, median 61 years).

The IIH patients were younger than the controls (P inferior 0.001) and more likely to be female (P = 0.16). Although the patients and controls deferred in respect of age and gender, this should not have affected comparisons between the two groups and the occurrence of the signs on MRI, as the signs we were looking for were unlikely to be related to age or gender. No associations were found with any of the MRI signs (odds ratio 0.96 - 1.07 for gender and 1.00 - 1.11 per decade of age: P superior 2.44 for both.

The MR imaging disclosed flattening of the posterior sclera in 80% of patients with pseudotumor cerebri, empty sella in 70%, distension of the perioptic subarachnoid space in 45%, enhancement of the prelaminar optic nerve in 50%, vertical tortuosity of the orbital optic nerve in 40%, and intraocular protrusion of the prelaminar optic nerve in 30% and stenosis of transverse sinus in 25%. Each neuroimaging sign was detected in 5% of control subjects, except for enhancement of the prelaminar optic nerve, which was not detected in control subjects.

Five signs were found to have significant association with IIH (P inferior 0.045, Fisher's exact test). These included: Pituitary deformity and empty sella turcica (figure 1), posterior globe flattening (figures 2 and 3), optic nerve sheath distention (figure 2, 3, 4 and 5), optic nerve tortuosity (figure.3, 4, and 5), optic nerve enhancement and transverse venous sinus stenosis (figure 6).

Three signs were not significantly associated with IIH; these included optic nerve root protrusion (figure.3 and 4), slit-like ventricles and tight CS spaces (P superior 0.05, Fisher's exact test).

Based on these MR imaging signs, the examiner was able to predict the presence of elevated intracranial pressure in 90% of cases with pseudotumor cerebri and the absence of elevated intracranial pressure in all control subjects.

Discussion:

Previously reported MR and computed tomography (CT) studies evaluating the role of cross-sectional brain imaging in IIH have concluded that there are structural signs that are helpful in establishing this diagnosis (3-8). Wisberg evaluated several signs (small ventricles, no visualized cisterns, prominent cisterna magna, empty sella or enlarged...
optic nerves) using CT in 28 patients (3). There was no control group in the study, this author concluded that some abnormality is seen in 36% of IIH patients.

Later studies used controls for comparison and evaluated a variety of signs by CT or MR. The optic nerve sheaths were found to be significantly wider in IIH patients compared with controls and several studies (4, 7, 8). Others noted that in enlarged, elongated subarachnoid space around the optic nerve was indeed more common in IIH patients than in healthy controls but did not find this observation to be statistically significant (6). Flattening of the posterior aspect of the globe was reported to be significantly more prevalent in IIH patients (8). The more extreme form of flattening, protrusion of the head of the optic nerve), was a repeatedly reported as being more common in IIH patients, but this was not statistically significant (4, 7, 8). Enhancement and the vertical tortuosity of the optic nerve were also reported to be significant signs for IIH (8, 12). Brodsky (8) even stated that single examiner could predicts the presence of elevated intracranial pressure in 90% of cases with IIH and the absence of elevated intracranial pressure in all controls. This was based on the following MR: Empty sella, enhancement and vertical tortuosity of the optic nerve. The degree of empty sella turcica had been reported to be more severe in IIH patients a few years early (3, 4). A quantitative MR analysis of the pituitary morphology demonstrates a significant decrease in the pituitary gland to sella turcica area ratio in patient with IIH (5, 13). Although early reports of studies using CT suggested that patients with IIH had slit ventricles (3), our findings concur with all subsequent reports, confirming that the size of the cerebral ventricles and of the subarachnoid spaces are normal in patients with IIH (4, 5, 7, 14-16).

The study confirms that the sign of flattening of the posterior aspect of the globe when present is highly suggestive of the diagnosis of IIH and is a fairly accurate sign. It should be kept in mind that these signs can be used as a sign for IIH only when there is no other abnormality on the brain MR that can cause increased intracranial pressure (including signs of venous thrombosis). This is because posterior globe flattening could potentially appear in any condition causing an increase in intracranial pressure and papilledema.

A recent study using a technique of contrast-enhanced MRV, found that narrowing of the distal transverse sinuses was strongly associated with IIH. It was also shown that application of a simple grading scheme for the degree of stenosis provided a highly sensitive (93%) and specific (93%) test for identifying patients with IIH (2). Transverse sinus stenosis was noted in 25 % of our cases which support further this association.
**Fig. 1:** Sagittal T1 weighted image, shows partially empty sella.

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Fig. 2: Axial fat suppressed T2 weighted image, demonstrates widening of peri-optic nerve subarachnoid spaces, flattening of posterior eye globes and tortuous optic nerves.

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Fig. 3: Oblique sagittal fat suppressed T2 weighted image for right orbit, showing tortuous optic nerve with protrusion of optic nerve head and wide ONS.

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Fig. 4: Oblique sagittal fat suppressed T2 weighted image for left orbit, showing tortuous optic nerve with protrusion of optic nerve head and wide ONS.

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**Fig. 5:** Oblique sagittal fat suppressed T2 weighted image for right orbit, showing tortuous optic nerve, flattening of posterior sclera, protrusion of optic nerve head and wide ONS.

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**Fig. 6:** Coronal fat supressed T2 weighted image, shows widening of subarachnoid spaces around optic nerves.

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Fig. 7: A narrowed left transverse sinus is seen on MR venography, in addition to ONS enlargement on axial MR imaging.

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Conclusion

Elevated intracranial pressure produces a constellation of MR imaging signs that can assist in establishing the diagnosis of pseudotumor cerebri.

Brain MRI and MRV significantly increased the diagnostic certainty for IIH if there was no evidence of a mass lesion, hydrocephalus, or sinus thrombosis and at least one of the following signs was present: flattening of the posterior globe, partially empty sella.